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Kojima et al.

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(54) **ROTARY DAMPER**

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(73) Assignee: **Oiles Corporation**, Tokyo (JP)

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Related U.S. Application Data

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(30) **Foreign Application Priority Data**

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Mar. 13, 2009 (JP) 2009-062102

(51) **Int. Cl.**
F16F 9/44 (2006.01)
F16F 9/14 (2006.01)

(52) **U.S. Cl.**
CPC .. ***F16F 9/44*** (2013.01); ***F16F 9/145*** (2013.01)

(58) **Field of Classification Search**
CPC F16F 9/145; F16F 9/44
USPC 188/290, 306, 307; 16/82, 51
See application file for complete search history.

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(74) *Attorney, Agent, or Firm* — Nixon & Vanderhye P.C.

(57) **ABSTRACT**

A rotary damper **1** includes a synthetic resin-made accommodating case **4** for accommodating in its interior **2** a viscous fluid **3** which is constituted by silicone oil or the like and whose viscosity declines with a temperature rise, and a synthetic resin-made rotor **9** which is disposed in the interior **2** of the accommodating case **4** rotatably, i.e., so as to be rotatable in R1 and R2 directions about an axis O, and which partitions the interior **2** of the accommodating case **4** into at least two chambers, i.e., in this embodiment, two chambers consisting of chambers **5** and **6** and two chambers consisting of chambers **7** and **8**, in cooperation with the accommodating case **4**.

4 Claims, 9 Drawing Sheets

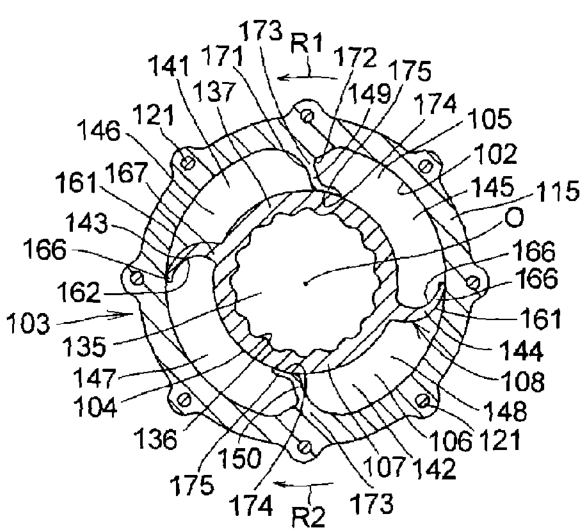

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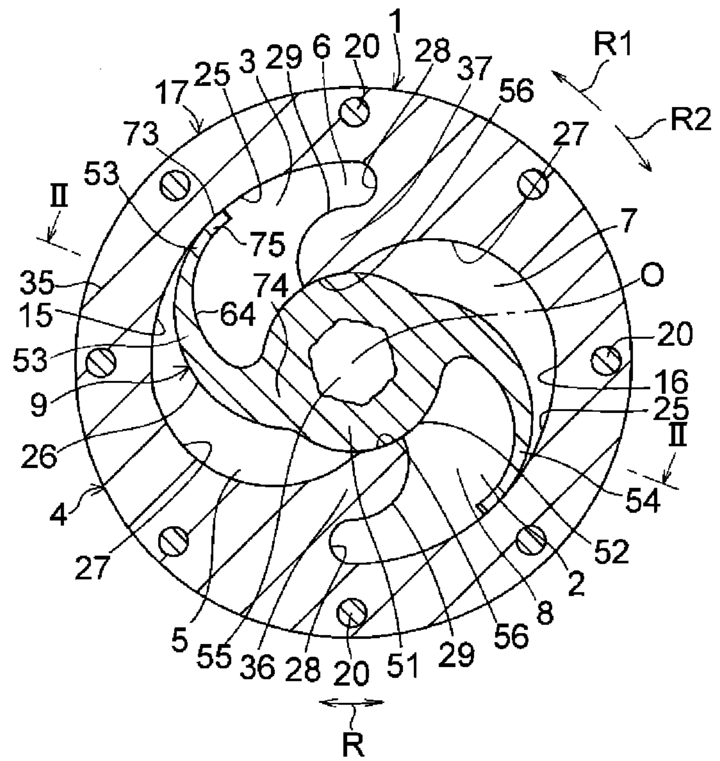
FIG. 1


1
R1
R2
17
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3
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O
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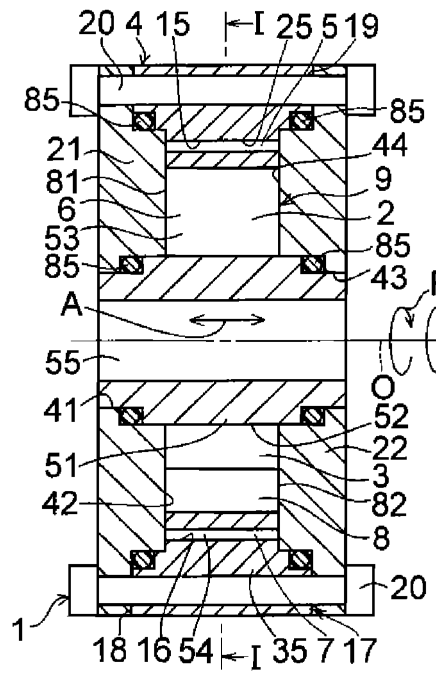
R

FIG. 2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2
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R2
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O
R1
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18 16 54
I
35 7 17

FIG. 3

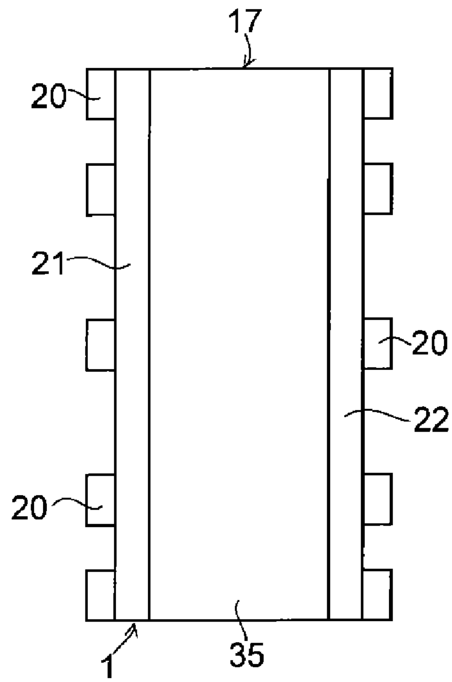


FIG. 4

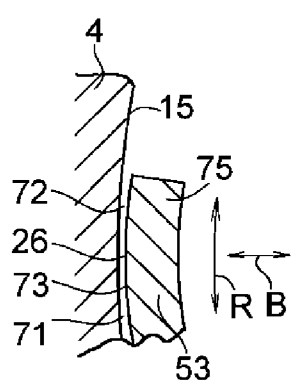
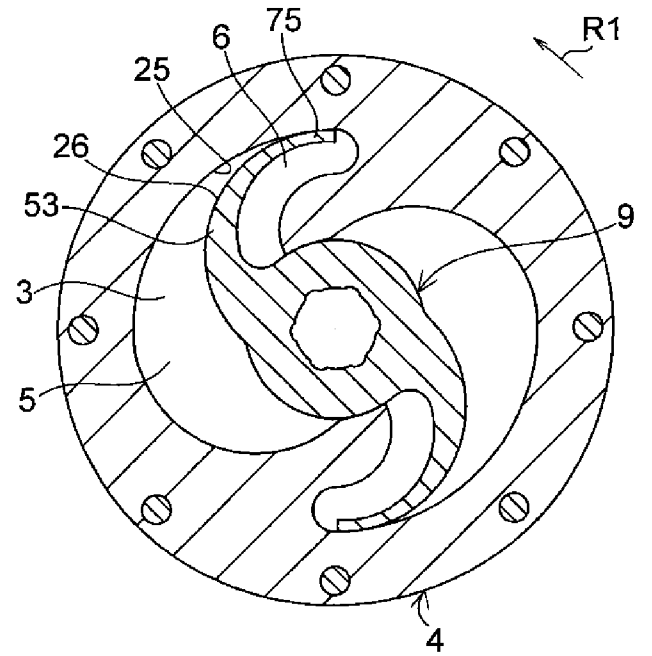


FIG. 5



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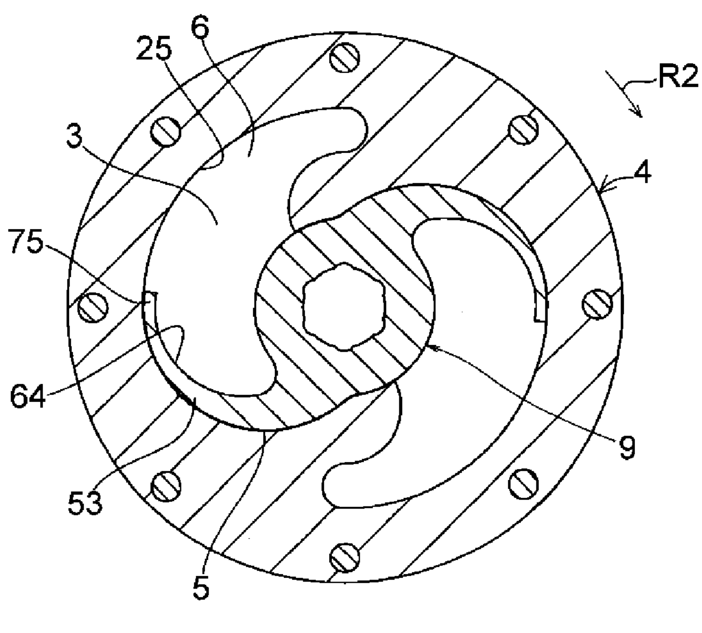

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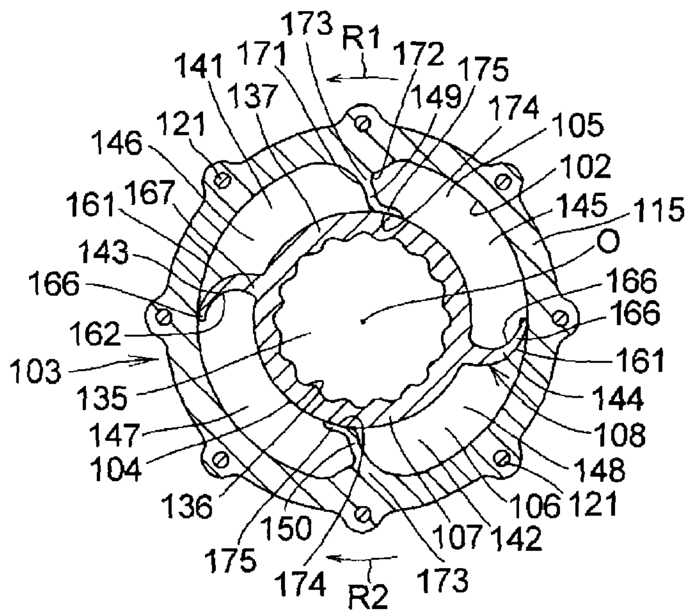
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R1
141
171
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175
137
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174
105
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121
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145
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O
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166
162
161
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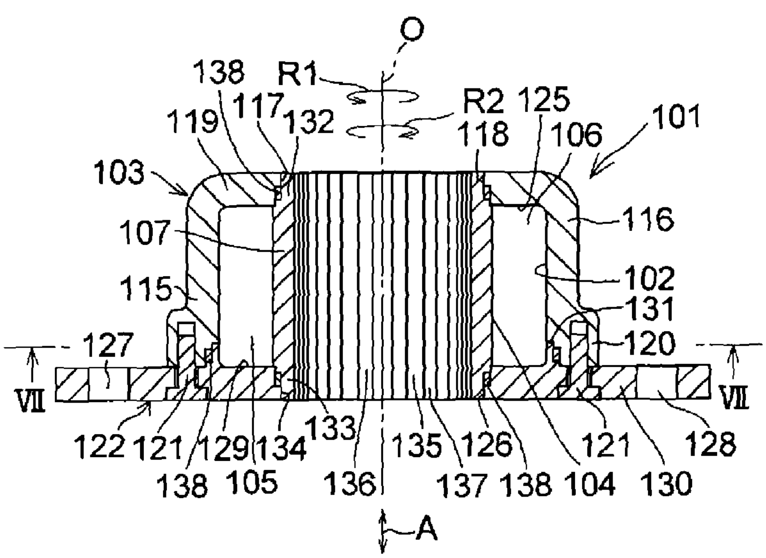
173
R2

FIG. 8


O
138
R1
R2
125
119
117
132
118
106
101
103
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102
115
131
127
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VII
VII
122
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104
130
A

FIG. 9

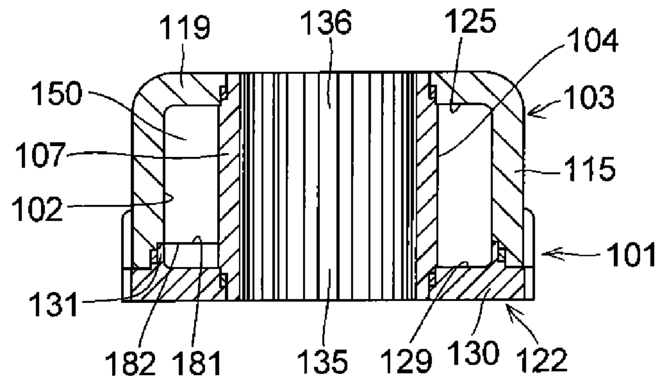
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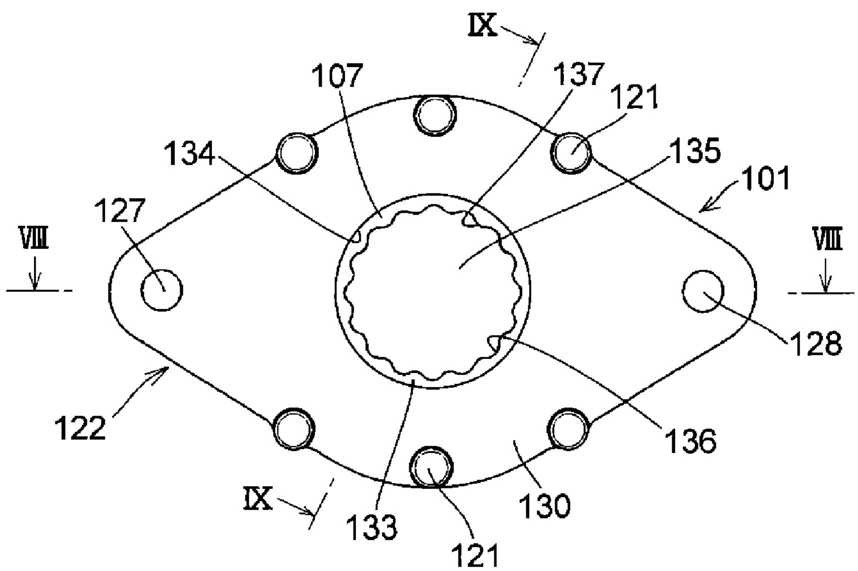
FIG. 10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101
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VIII
VIII
128
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130
IX
133
121

FIG. 11

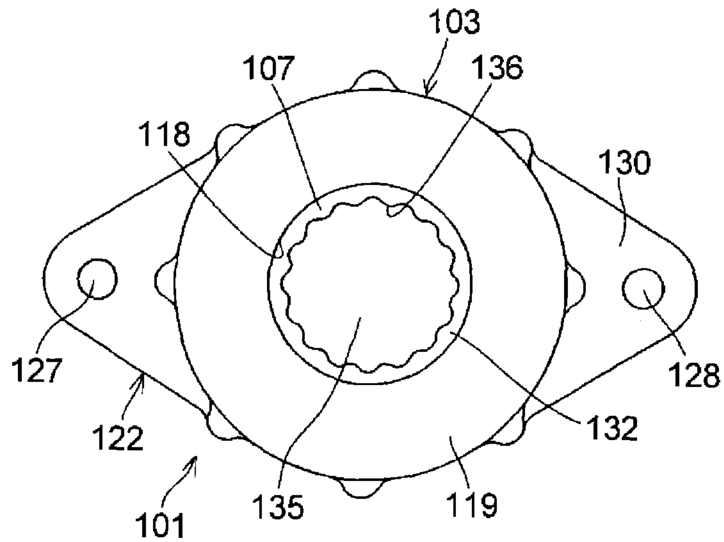
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FIG. 12

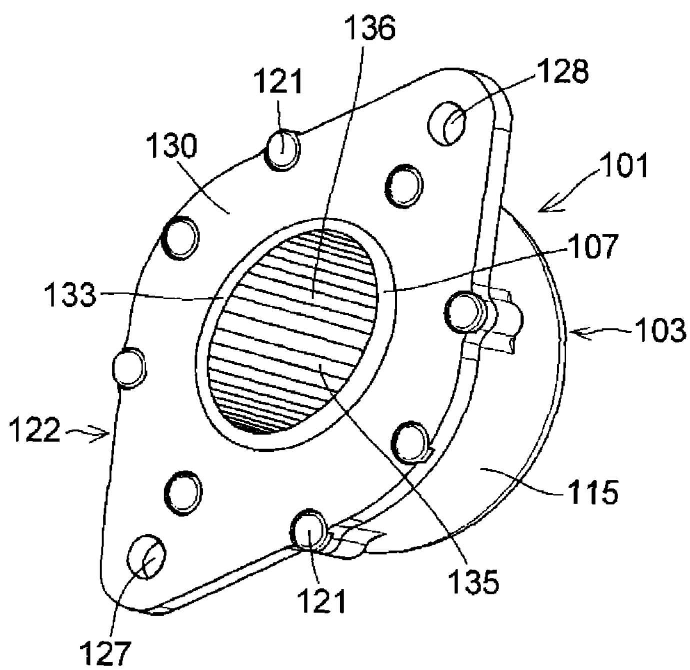
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FIG. 13

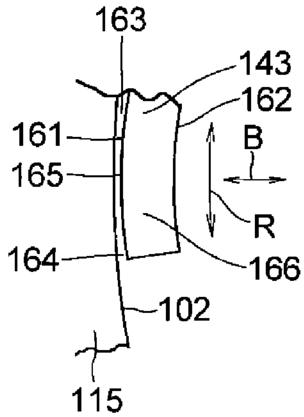


FIG. 14

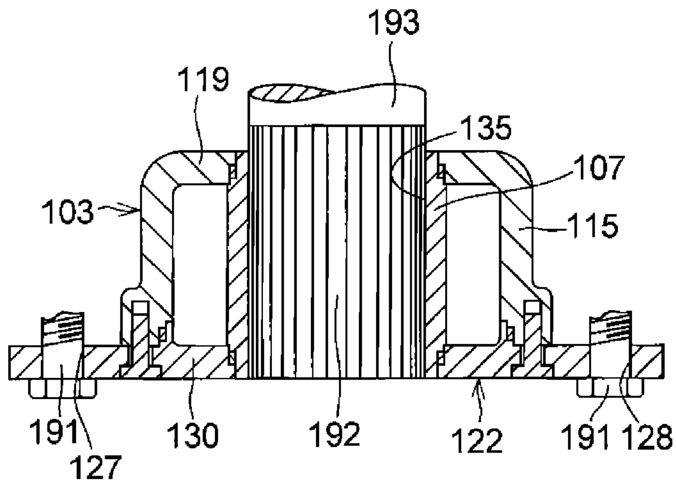


FIG. 15

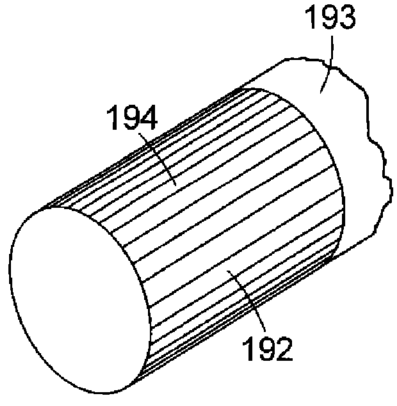
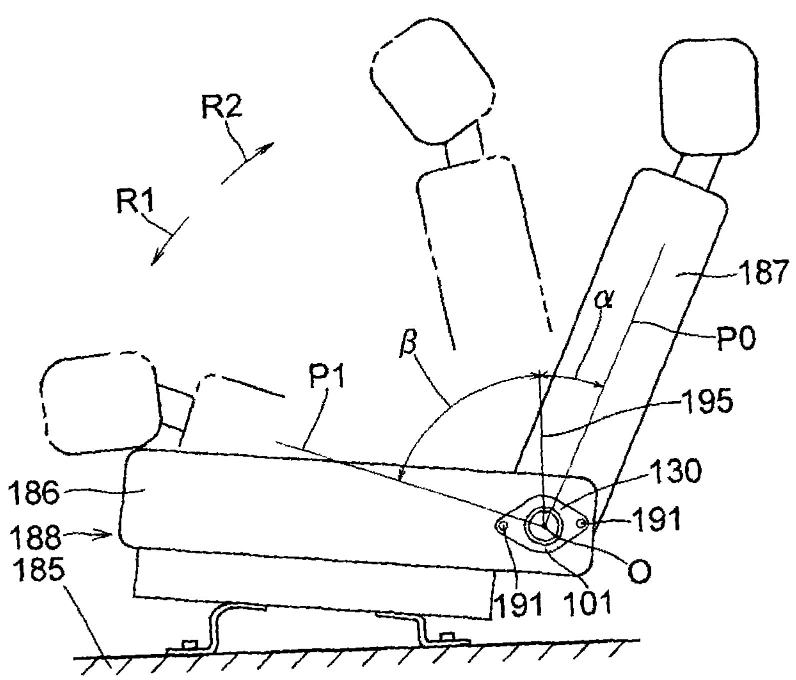


FIG. 16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187
α
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FIG. 17

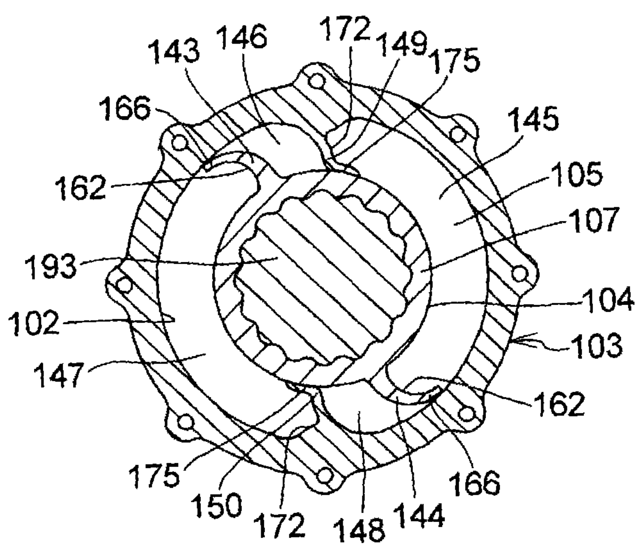
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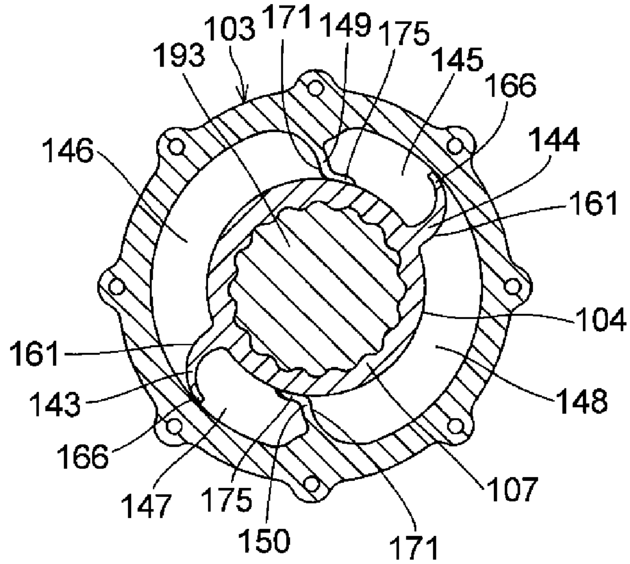
FIG. 18



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ROTARY DAMPER

This application is a divisional of U.S. patent application Ser. No. 13/129,655, filed 17 May 2011, which is the U.S. national phase of International Application No. PCT/JP2009/006206, filed 18 Nov. 2009, which designated the U.S. and claims priority to Japan Application No. 2008-297376, filed 20 Nov. 2008; and Japan Application No. 2009-062102, filed 13 Mar. 2009, the entire contents of each of which are hereby incorporated by reference.

TECHNICAL FIELD

The present invention relates to a rotary damper in which a rotor having vanes is rotatably accommodated in the interior of an accommodating case for accommodating a viscous fluid, and braking is imparted by the viscous fluid to the relative rotation of the rotor with respect to the accommodating case.

BACKGROUND ART

Unidirectional rotary dampers of this type in which large braking is imparted to the rotation of the rotor in one direction by a viscous fluid which passes through clearances and small braking is imparted to the rotation of the rotor in the other direction are known from Patent Document 1 and the like.

PRIOR ART DOCUMENTS

Patent Documents

Patent Document 1: JP-A-2005-188636
Patent Document 2: JP-A-9-42350
Patent Document 3: JP-A-9-329173
Patent Document 4: JP-A-8-109940
Patent Document 5: JP-A-8-296687

SUMMARY OF THE INVENTION

Problems that the Invention is to Solve

With such a rotary damper, since the viscosity of the viscous fluid changes depending on the temperature, braking decreases in use under high temperature, while braking increases in use under low temperature. Therefore, the use of the rotary damper of this type is not suitable in the case of equipment for which braking that does not change even at high temperature or low temperature is required, such as a vehicle seat for an automobile or the like which has a foldable backrest portion and which is not subjected to constant temperature control at an installation site such as outdoors.

The present invention has been devised in view of the above-described aspects, and its object is to provide a rotary damper which is suitable for use in a vehicle seat for an automobile or the like, in which braking that is generated is free of temperature dependence, and which makes it possible to obtain braking which does not change even at high temperature or low temperature.

Means for Solving the Problems

A rotary damper in accordance with the present invention comprises: an accommodating case for accommodating in its interior a viscous fluid whose viscosity declines with a temperature rise and a rotor which is disposed rotatably in the interior of the accommodating case and which partitions the

interior of the accommodating case into at least two chambers in cooperation with the accommodating case, wherein the rotor has a rotor body which is rotatably supported in the accommodating case and an elastic vane which is provided on an outer peripheral surface of the rotor body, wherein the elastic vane includes a curved projecting surface which is continuously connected at one end to the outer peripheral surface of the rotor body and opposes at another end an inner peripheral surface of the accommodating case, and which forms one of the two chambers in cooperation with the inner peripheral surface of the accommodating case, and a curved recessed surface which is continuously connected at one end to the outer peripheral surface of the rotor body in correspondence with the projecting surface and extends along the projecting surface, and which forms the other one of the two chambers in cooperation with the inner peripheral surface of the accommodating case, and wherein the projecting surface has on its other end side a circular arc-shaped projecting surface which forms between the same and the inner peripheral surface of the accommodating case a pair of wedge spaces opposing each other in a circumferential direction, the circular arc-shaped projecting surface determines a radial width of one wedge space communicating with one of the two chambers such that the radial width of the one wedge space becomes gradually narrow toward another one of the wedge spaces in the circumferential direction, and the circular arc-shaped projecting surface determines a radial width of the other wedge space communicating with another one of the two chambers such that the radial width of the other wedge space becomes gradually narrow toward the one wedge space in the circumferential direction, and wherein the viscous fluid passing through the pair of wedge spaces is adapted to determine the radial width of the pair of wedge spaces by means of its viscosity by elastically deflecting the elastic vane.

According to the rotary damper in accordance with the present invention, when the rotor is rotated with respect to the accommodating case so as to reduce one chamber and enlarge the other chamber, the pressure of the viscous fluid is imparted to the curved projecting surface of the elastic vane, so that the elastic vane is elastically deformed such that the other end side of the elastic vane moves away from the inner peripheral surface of the accommodating case to widen the pair of wedge spaces. As a result, the viscous fluid passes through the pair of widened wedge spaces and flows from the one chamber into the other chamber, thereby imparting to the rotation of the rotor small braking due to the viscous fluid passing through the pair of widened wedge spaces. Meanwhile, when the rotor is rotated with respect to the accommodating case so as to enlarge the one chamber and reduce the other chamber, the pressure of the viscous fluid is imparted to the recessed surface of the elastic vane, so that the elastic vane is elastically deformed such that the other end side of the elastic vane approaches the inner peripheral surface of the accommodating case to narrow the pair of wedge spaces. As a result, the viscous fluid passes through the pair of narrowed wedge spaces and flows from the other chamber into the one chamber, thereby imparting to the rotation of the rotor large braking due to the viscous fluid passing through the pair of narrowed wedge spaces. Thus, the rotary damper is adapted to function as a unidirectional damper.

In addition, according to the rotary damper in accordance with the present invention, the viscous fluid whose viscosity declines with a temperature rise passes through the pair of wedge spaces in the rotation of the rotor. Therefore, in a case where, for example, the viscous fluid whose viscosity at low temperature has increased more than at normal temperature (20° C.) passes through the pair of wedge spaces, the elastic vane is caused to undergo elastic deformation such that the other end side of the elastic vane moves away from the inner peripheral surface of the accommodating case owing to the increased pressure of the viscous fluid at the pair of wedge spaces, so that the pair of wedge spaces are widened. As a result, by virtue of the increased viscosity of the viscous fluid itself and a decline in the flow resistance based on the widening of the pair of wedge spaces, it is possible to maintain the braking persisting during normal temperature despite the low temperature. Meanwhile, in a case where the viscous fluid whose viscosity at high temperature has decreased more than at normal temperature passes through the pair of wedge spaces, the elastic vane is caused to undergo elastic deformation such that the other end side of the elastic vane approaches the inner peripheral surface of the accommodating case owing to the decreased pressure of the viscous fluid at the pair of wedge spaces, so that the pair of wedge spaces are narrowed. As a result, by virtue of the decreased viscosity of the viscous fluid itself and an increase in the flow resistance based on the narrowing of the pair of wedge spaces, it becomes possible to maintain the braking persisting during normal temperature despite the high temperature. Hence, the braking which is generated is free of temperature dependence, and it is possible to obtain braking which does not change even at high temperature or low temperature.

In a preferred example of this rotary damper, the inner peripheral surface of the accommodating case includes a cylindrical inner peripheral surface which forms the one wedge space in cooperation with the circular arc-shaped projecting surface and a curved recessed inner peripheral surface which is continuously connected to the cylindrical inner peripheral surface and has a complementary shape to the projecting surface, and the circular arc-shaped projecting surface has a smaller radius of curvature than a radius of curvature of the cylindrical inner peripheral surface.

In addition, a rotary damper in accordance with the present invention comprises: an accommodating case having a cylindrical inner peripheral surface; a rotor disposed in an interior of the accommodating case relatively rotatably with respect to the accommodating case so as to form a space for accommodating between the cylindrical inner peripheral surface of the accommodating case and a cylindrical outer peripheral surface concentric with that inner peripheral surface a viscous fluid whose viscosity declines with a temperature rise; and vane means disposed in the space accommodating the viscous fluid between the cylindrical inner peripheral surface of the accommodating case and the cylindrical outer peripheral surface of the rotor so as to cause large flow resistance to be generated in the viscous fluid in the relative rotation in one direction of the rotor with respect to the accommodating case and so as to cause smaller flow resistance than that flow resistance to be generated therein in the relative rotation in another direction opposite to the relative rotation in the one direction of the rotor with respect to the accommodating case, wherein the vane means has a pair of elastic vanes for partitioning into two chambers the space accommodating the viscous fluid between the cylindrical inner peripheral surface of the accommodating case and the cylindrical outer peripheral surface of the rotor and another elastic vane for further partitioning into two chambers at least one of the two chambers partitioned by the pair of elastic vanes, wherein each of the pair of elastic vanes includes a curved projecting surface which is continuously connected at its one end portion to the outer peripheral surface of the rotor and which is projecting in an opposite direction to the relative rotation in the one direction of the rotor with respect to the accommodating case, and a curved recessed surface which is continuously connected at its one end portion to the outer peripheral surface of the rotor in correspondence with the projecting surface, and which extends along the projecting surface, and wherein the projecting surface has on its other end portion side a circular arc-shaped projecting surface which forms between the same and the inner peripheral surface of the accommodating case a pair of wedge spaces opposing each other in a rotational direction of the relative rotation of the rotor with respect to the accommodating case, the circular arc-shaped projecting surface determines a radial width of one of the wedge spaces communicating with one of the two chambers adjacent to each other with the circular arc-shaped projecting surface therebetween in the rotational direction of the relative rotation of the rotor with respect to the accommodating case, such that the radial width of the one wedge space becomes gradually narrow toward another one of the wedge spaces communicating with another one of the chambers adjacent to each other with the circular arc-shaped projecting surface therebetween in the rotational direction of the relative rotation of the rotor with respect to the accommodating case, and the circular arc-shaped projecting surface determines a radial width of the other wedge space communicating with the other one of the two chambers adjacent to each other with the circular arc-shaped projecting surface therebetween in the rotational direction of the relative rotation of the rotor with respect to the accommodating case, such that the radial width of the other wedge space becomes gradually narrow toward the one wedge space communicating with the one of the two chambers adjacent to each other with the circular arc-shaped projecting surface therebetween in the rotational direction of the relative rotation of the rotor with respect to the accommodating case, the viscous fluid passing through the pair of wedge spaces is adapted to determine the radial width of the pair of wedge spaces by means of its viscosity by elastically deflecting each of the pair of elastic vanes.

With the above-described rotary damper as well, when the rotor is rotated with respect to the accommodating case so as to enlarge one chamber located on the relative rotation side in the other opposite direction to the relative rotation in the one direction of the rotor with respect to the accommodating case and reduce the other chamber on the relative rotation side in the one direction of the rotor with respect to the accommodating case between the two chambers which are partitioned by the respective pair of elastic vanes and are adjacent to each other in the rotational direction of the relative rotation of the rotor with respect to the accommodating case, the pressure of the viscous fluid is imparted to the respective recessed surfaces of the pair of elastic vanes. Therefore, each of the pair of elastic vanes is elastically deformed such that the other end side of each of the pair of elastic vanes approaches the inner peripheral surface of the accommodating case to narrow the pair of wedge spaces. As a result, the viscous fluid passes through the pair of narrowed wedge spaces and flows from the other chamber into the one chamber, thereby imparting to the rotation of the rotor large braking due to the viscous fluid passing through the pair of narrowed wedge spaces. Meanwhile, when the rotor is rotated with respect to the accommodating case so as to reduce the one chamber and enlarge the other chamber, the pressure of the viscous fluid is imparted to the respective curved projecting surfaces of the pair of elastic vanes. Therefore, each of the pair of elastic vanes is elastically deformed such that the other end side of each of the pair of elastic vanes moves away from the inner peripheral surface of the accommodating case to widen the pair of wedge spaces. As a result, the viscous fluid passes through the pair of widened wedge spaces and flows from the one chamber into the other chamber, thereby imparting to the rotation of the rotor small braking due to the viscous fluid passing through the pair of widened wedge spaces. Thus, the rotary damper is adapted to function as a unidirectional damper.

In addition, according to the rotary damper, the viscous fluid whose viscosity declines with a temperature rise passes through the pair of wedge spaces in the rotation of the rotor. Therefore, in a case where, for example, the viscous fluid whose viscosity at low temperature has increased more than at normal temperature (20° C.) passes through the pair of wedge spaces, each of the pair of elastic vanes is caused to undergo elastic deformation such that the other end side of each of the pair of elastic vanes moves away from the inner peripheral surface of the accommodating case owing to the increased pressure of the viscous fluid at the pair of wedge spaces, so that the pair of wedge spaces are widened. As a result, by virtue of the increased viscosity of the viscous fluid itself and a decline in the flow resistance based on the widening of the pair of wedge spaces, it is possible to maintain the braking persisting during normal temperature despite the low temperature. Meanwhile, in a case where the viscous fluid whose viscosity at high temperature has decreased more than at normal temperature passes through the pair of wedge spaces, each of the pair of elastic vanes is caused to undergo elastic deformation such that the other end side of each of the pair of elastic vanes approaches the inner peripheral surface of the accommodating case owing to the decreased pressure of the viscous fluid at the pair of wedge spaces, so that the pair of wedge spaces are narrowed. As a result, by virtue of the decreased viscosity of the viscous fluid itself and an increase in the flow resistance based on the narrowing of the pair of wedge spaces, it becomes possible to maintain the braking persisting during normal temperature despite the high temperature. Hence, the braking which is generated is free of temperature dependence, and it is possible to obtain braking which does not change even at high temperature or low temperature.

In another preferred example of this rotary damper, the circular arc-shaped projecting surface has a smaller radius of curvature than a radius of curvature of the inner peripheral surface of the accommodating case.

In addition, in still another preferred example of the above-described rotary damper, the other elastic vane includes a proximal portion which is integrally formed on the inner peripheral surface of the accommodating case and an elastically flexible tongue portion which is integrally formed on the proximal portion and has a circular arc-shaped surface opposing the outer peripheral surface of the rotor.

In each of the above-described other elastic vanes, the tongue portion may have a circular arc-shaped recessed surface which forms between the same and the outer peripheral surface of the rotor a pair of wedge spaces opposing each other in a rotational direction of the relative rotation of the rotor with respect to the accommodating case. This circular arc-shaped recessed surface determines the radial width of one of the wedge spaces communicating with one of the two chambers adjacent to each other with that circular arc-shaped recessed surface therebetween in the rotational direction of the relative rotation of the rotor with respect to the accommodating case, such that the radial width of the one wedge space becomes gradually narrow toward the other wedge space communicating with the other one of the adjacent two chambers. This circular arc-shaped recessed surface also determines the radial width of the other wedge space communicating with the other one of the adjacent two chambers, such that the radial width of the other wedge space becomes gradually narrow toward the one wedge space communicating with the one of the adjacent two chambers. Thus, the viscous fluid passing through the pair of wedge spaces may be adapted to determine the radial width of the pair of wedge spaces by means of its viscosity by elastically deflecting each of the other elastic vanes.

According to any one of the above-described rotary dampers, in a further preferred example, the recessed surface extends along the projecting surface so as to gradually approach the projecting surface from the one end portion to the other end portion of the projecting surface.

In the present invention, as the viscous fluid, it is possible to cite silicone oil as a preferable example, but another viscous fluid may be used. In addition, the accommodating case may be made of a metal, but may be made of a hard synthetic resin for such reasons as weight saving, cost reduction, and the like. Also, the rotor may be made of a metal, but may be made of a hard synthetic resin for such reasons as weight saving, cost reduction, and the like. The elastic vane may be formed separately from the rotor body and may be secured to the rotor body by means of welding, fitting, bonding, or the like. Preferably, however, the elastic vane is integrally formed on the rotor body. In the case where the rotor body and the elastic vane are integrally formed, as the rotor it is preferable to use a synthetic resin material which imparts appropriate elasticity to the elastic vane. The pair of elastic vanes may also be formed separately from the rotor and may be secured to the rotor by means of welding, fitting, bonding, or the like. Preferably, however, the pair of elastic vanes are integrally formed on the rotor. In the case where the rotor and the pair of elastic vanes are integrally formed, as the rotor it is preferable to use a synthetic resin material which imparts appropriate elasticity to each of the pair of elastic vanes. In addition, the other elastic vanes may also be formed separately from the accommodating case and may be secured to the accommodating case by means of welding, fitting, bonding, or the like. Preferably, however, the other elastic vanes are integrally formed on the accommodating case. In the case where the accommodating case and the other elastic vanes are integrally formed, as the accommodating case it is preferable to use a synthetic resin material which imparts appropriate elasticity to each of the other elastic vanes.

Advantages of the Invention

According to the present invention, it is possible to provide a rotary damper which is suitable for use in a vehicle seat for an automobile or the like, in which braking that is generated is free of temperature dependence, and which makes it possible to obtain braking which does not change even at high temperature or low temperature.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an explanatory cross-sectional view, taken in the direction of arrows along line I-I shown in FIG. **2**, of a preferred embodiment of the present invention;

FIG. **2** is an explanatory cross-sectional view, taken in the direction of arrows along line II-II, of the preferred embodiment shown in FIG. **1**;

FIG. **3** is an explanatory external view of the embodiment shown in FIG. **1**;

FIG. **4** is a partially enlarged explanatory view of the embodiment shown in FIG. **1**;

FIG. **5** is a diagram explaining the operation of the embodiment shown in FIG. **1**;

FIG. **6** is a diagram explaining the operation of the embodiment shown in FIG. **1**;

FIG. **7** is an explanatory cross-sectional view, taken in the direction of arrows along line VII-VII shown in FIG. **8**, of another preferred embodiment of the present invention;

FIG. **8** is an explanatory cross-sectional view, taken in the direction of arrows along line VIII-VIII in FIG. **10**, of the embodiment shown in FIG. **7**;

FIG. **9** is an explanatory cross-sectional view, taken in the direction of arrows along line IX-IX in FIG. **10**, of the embodiment shown in FIG. **7**;

FIG. **10** is a front elevational view of the embodiment shown in FIG. **7**;

FIG. **11** is a rear view of the embodiment shown in FIG. **7**;

FIG. **12** is a perspective view of the embodiment shown in FIG. **7**;

FIG. **13** is a partially enlarged explanatory view of the embodiment shown in FIG. **7**;

FIG. **14** is an explanatory view in which a rotating shaft is fitted in the embodiment shown in FIG. **7**;

FIG. **15** is a perspective view of the rotating shaft shown in FIG. **14**;

FIG. **16** is an explanatory diagram of an example in which the embodiment shown in FIG. **7** is installed in a vehicle seat;

FIG. **17** is a diagram explaining the operation of the embodiment shown in FIG. **7**; and

FIG. **18** is a diagram explaining the operation of the embodiment shown in FIG. **7**.

MODE FOR CARRYING OUT THE INVENTION

Next, a more detailed description will be given of a mode for carrying out the invention with reference to the preferred embodiments illustrated in the drawings. It should be noted that the invention is not limited to these embodiments.

In FIGS. **1** to **4**, a rotary damper **1** in accordance with this embodiment is comprised of a synthetic resin-made accommodating case **4** for accommodating in its interior **2** a viscous fluid **3** which is constituted by silicone oil or the like and whose viscosity declines with a temperature rise, as well as a synthetic resin-made rotor **9** which is disposed in the interior **2** of the accommodating case **4** rotatably, i.e., so as to be rotatable in R1 and R2 directions about an axis O, and which partitions the interior **2** of the accommodating case **4** into at least two chambers, i.e., in this embodiment, two chambers consisting of chambers **5** and **6** and two chambers consisting of chambers **7** and **8**, in cooperation with the accommodating case **4**.

The accommodating case **4** is comprised of a cylinder **17** having inner peripheral surfaces **15** and **16** and of a pair of covers **21** and **22** which are respectively secured to one and the other annular end surfaces **18** and **19** in an axial direction A of the cylinder **17** by means of a plurality of screws **20**.

Since the inner peripheral surfaces **15** and **16** are formed in a mutually similar manner with symmetrical shapes about the axis O, a description will be given hereafter of the inner peripheral surface **15**. The inner peripheral surface **15** has a cylindrical inner peripheral surface **25** having the axis O as the center; a curved recessed inner peripheral surface **27** which is continuously connected to one end of the cylindrical inner peripheral surface **25** and has a complementary shape to a projecting surface **26** of the rotor **9**; a cylindrical inner peripheral surface **28** which is continuously connected at one end to the other end of the cylindrical inner peripheral surface **25**; and a cylindrical inner peripheral surface **29** which is continuously connected at one end to the other end of the cylindrical inner peripheral surface **28**. Each of the cylindrical inner peripheral surface **25** and the cylindrical inner peripheral surface **28** is constituted by a recessed surface in the same way as the curved recessed inner peripheral surface **27**, and the cylindrical inner peripheral surface **29** is constituted by a projecting surface.

The cylinder **17** includes a cylindrical body **35** having the cylindrical inner peripheral surface **25**, as well as a pair of projections **36** and **37** which are integrally formed in a mutually similar manner with symmetrical shapes about the axis O. The projection **36** has the curved recessed inner peripheral surface **27** of the inner peripheral surface **15** as well as the cylindrical inner peripheral surface **28** and the cylindrical inner peripheral surface **29** of the inner peripheral surface **16**. The projection **37** has the curved recessed inner peripheral surface **27** of the inner peripheral surface **16** as well as the cylindrical inner peripheral surface **28** and the cylindrical inner peripheral surface **29** of the inner peripheral surface **15**.

The cover **21** having a through hole **41** in its center defines at its one side surface **42** in the axial direction A one side of the interior **2** in the axial direction A. The cover **22** having a through hole **43** in its center defines at its one side surface **44** in the axial direction A the other side of the interior **2** in the axial direction A.

The rotor **9** has a hollow rotor body **51** which is supported in the accommodating case **4** so as to be rotatable in the R1 and R2 directions, as well as a pair of elastic vanes **53** and **54** which are integrally provided on an outer peripheral surface **52** of the rotor body **51**.

A rotating shaft is adapted to be fitted in a hollow portion **55** at a central portion of the cylindrical rotor body **51**. As this rotating shaft rotates in the R1 and R2 directions, the rotor body **51** is adapted to be rotated in those directions, and an object to be dampened is connected to such a rotating shaft.

The outer peripheral surface **52** of the rotor body **51** is in contact with respective circular arc-shaped distal end surfaces **56** of the projections **36** and **37** slidably movably in the R1 and R2 directions. The two chambers consisting of the chambers **5** and **6** and the two chambers consisting of the chambers **7** and **8** are respectively separated from each other tightly by the contact between the outer peripheral surface **52** of the rotor body **51** and the respective circular arc-shaped distal end surfaces **56** of the projections **36** and **37**.

Since the elastic vanes **53** and **54** are formed in a mutually similar manner with symmetrical shapes about the axis O, a description will be given hereafter of the elastic vane **53**. The elastic vane **53** includes the curved projecting surface **26** which is continuously connected at one end to the outer peripheral surface **52** of the rotor body **51** and opposes at the other end the cylindrical inner peripheral surface **25** of the inner peripheral surface **15** of the accommodating case **4** in close proximity thereto, and which forms the one chamber **5** of the two chambers **5** and **6** in cooperation with the inner peripheral surface **15** of the accommodating case **4**, as well as a curved recessed surface **64** which is continuously connected at one end to the outer peripheral surface **52** of the rotor body **51** in correspondence with the projecting surface **26** and extends along the projecting surface **26**, and which forms the other chamber **6** of the two chambers **5** and **6** in cooperation with the inner peripheral surface **15** of the accommodating case **4**.

The projecting surface **26** has on its other end side a circular arc-shaped projecting surface **73** which forms between the same and the cylindrical inner peripheral surface **25** of the accommodating case **4** a pair of wedge spaces **71** and **72** opposing each other in a circumferential direction R, and which has a smaller radius of curvature than the radius of curvature of the cylindrical inner peripheral surface **25**. The circular arc-shaped projecting surface **73** determines the width in a radial direction B of the one wedge space **71** communicating with the chamber **5** such that the width in the radial direction B of the one wedge space **71** becomes gradually narrow toward the other wedge space **72** in the circumferential direction R. Also, the circular arc-shaped projecting surface **73** determines the width in the radial direction B of the other wedge space **72** communicating with the chamber **6** such that the width in the radial direction B of the other wedge space **72** becomes gradually narrow toward the one wedge space **71** in the circumferential direction R. Thus, the viscous fluid **3** passing through the pair of wedge spaces **71** and **72** is adapted to determine the width in the radial direction B of the pair of wedge spaces **71** and **72**, which allow the chambers **5** and **6** to communicate with each other, by means of its viscosity by deflecting the elastic vane **53**.

The recessed surface **64** extends along the projecting surface **26** so as to gradually approach the projecting surface **26** from the one end to the other end of the projecting surface **26**, and terminates at a terminating end of the projecting surface **26**. As a result, the elastic vane **53** is formed so as to be gradually thinner from its proximal portion **74**, to which the rotor body **51** is continuously connected, to its other end **75** which is a free end.

The one side surface **42** in the axial direction A of the cover **21** is slidably in close contact with one end surface **81** in the axial direction A of the rotor **9** so as to be rotatable in the R1 and R2 directions. The one side surface **44** in the axial direction A of the cover **22** is slidably in close contact with the other end surface **82** in the axial direction A of the rotor **9** so as to be rotatable in the R1 and R2 directions.

Seal rings **85** for preventing the leakage of the viscous fluid **3** from the chambers **5** and **6** to outside the accommodating case **4** are respectively disposed between the side surface **42** of the cover **21** and each of the cylindrical body **35** and the rotor body **51** and between the side surface **44** of the cover **21** and each of the cylindrical body **35** and the rotor body **51**.

With the above-described rotary damper **1**, at the rotational position of the rotor **9** shown in FIG. **5**, when the rotor **9** is rotated in the R1 direction with respect to the accommodating case **4** so as to reduce the one chamber **5** and enlarge the other chamber **6**, the pressure of the viscous fluid **3** is imparted to the curved projecting surface **26** of the elastic vane **53**, so that the elastic vane **53** is elastically deformed such that the other end **75** side of the elastic vane **53** moves away from the cylindrical inner peripheral surface **25** of the accommodating case **4** to widen the pair of wedge spaces **71** and **72**. As a result, the viscous fluid **3** passes through the pair of widened wedge spaces **71** and **72** and flows from the one chamber **5** into the other chamber **6**, thereby imparting to the rotation in the R1 direction of the rotor **9** small braking based on the flow resistance of the viscous fluid **3** passing through the pair of widened wedge spaces **71** and **72**. Meanwhile, at the rotational position of the rotor **9** shown in FIG. **6**, when the rotor **9** is rotated in the R2 direction with respect to the accommodating case **4** so as to enlarge the one chamber **5** and reduce the other chamber **6**, the pressure of the viscous fluid **3** is imparted to the recessed surface **64** of the elastic vane **53**, so that the elastic vane **53** is elastically deformed such that the other end **75** side of the elastic vane **53** approaches the cylindrical inner peripheral surface **25** of the accommodating case **4** to narrow the pair of wedge spaces **71** and **72**. As a result, the viscous fluid **3** passes through the pair of narrowed wedge spaces **71** and **72** and flows from the other chamber **6** into the one chamber **5**, thereby imparting to the rotation in the R2 direction of the rotor **9** large braking based on the flow resistance of the viscous fluid **3** passing through the pair of narrowed wedge spaces **71** and **72**. Thus, the rotary damper **1** functions as a unidirectional damper.

In addition, with the rotary damper **1**, the viscous fluid **3** whose viscosity declines with a temperature rise is adapted to pass through the pair of wedge spaces **71** and **72** in the rotation in the R1 and R2 directions of the rotor **9**. Therefore, in a case where, for example, the viscous fluid **3** whose viscosity at low temperature has increased more than at normal temperature passes through the pair of wedge spaces **71** and **72**, the elastic vane **53** is caused to undergo large elastic deformation such that the other end **75** side of the elastic vane **53** moves away from the cylindrical inner peripheral surface **25** of the accommodating case **4** more than at normal temperature owing to the increased pressure of the viscous fluid **3** at the pair of wedge spaces **71** and **72**, so that the pair of wedge spaces **71** and **72** are largely widened as compared with the time of normal temperature. As a result, by virtue of an increase in the flow resistance based on the increased viscosity of the viscous fluid **3** itself and a decline in the flow resistance based on the widening of the pair of wedge spaces **71** and **72**, it is possible to maintain the braking persisting during normal temperature despite the low temperature. Meanwhile, in a case where the viscous fluid **3** whose viscosity at high temperature has decreased more than at normal temperature passes through the pair of wedge spaces **71** and **72**, the elastic vane **53** is caused to undergo small elastic deformation such that the other end **75** side of the elastic vane **53** approaches the cylindrical inner peripheral surface **25** of the accommodating case **4** more than at normal temperature owing to the decreased pressure of the viscous fluid **3** at the pair of wedge spaces **71** and **72**, so that the pair of wedge spaces **71** and **72** are narrowed. As a result, by virtue of a decrease in the flow resistance based on the decreased viscosity of the viscous fluid **3** itself and an increase in the flow resistance based on the narrowing of the pair of wedge spaces **71** and **72**, it is possible to maintain the braking persisting during normal temperature despite the high temperature. Hence, the braking which is generated is free of temperature dependence, and it is possible to obtain braking which does not change even at high temperature or low temperature.

The above-described operation is effected in the same way on the elastic vane **54** side as well.

The above-described rotary damper **1** has the pair of elastic vanes **53** and **54**, however, the rotary damper in accordance with the present invention may have one or three or more elastic vanes in substitution of such a pair of elastic vanes.

A rotary damper **101** in accordance with another embodiment shown in FIGS. **7** to **13** is comprised of a synthetic resin-made accommodating case **103** having a cylindrical inner peripheral surface **102**; a synthetic resin-made rotor **107** disposed in the interior of the accommodating case **103** relatively rotatably in the R1 and R2 directions about the axis O with respect to the accommodating case **103** so as to form a space **106** for accommodating between the inner peripheral surface **102** and a cylindrical outer peripheral surface **104** concentric with the inner peripheral surface **102** about the axis O a viscous fluid **105** which is constituted by silicone oil or the like and whose viscosity declines with a temperature rise; and a vane means **108** disposed in the space **106** so as to cause large flow resistance to be generated in the viscous fluid **105** in the relative rotation in one direction of the rotor **107** with respect to the accommodating case **103**, i.e., in this embodiment in the rotation in the R1 direction of the rotor **107** with respect to the accommodating case **103**, and so as to cause smaller flow resistance than that flow resistance to be generated therein in the relative rotation in the other opposite direction to the relative rotation in the one direction of the rotor **107** with respect to the accommodating case **103**, i.e., in this embodiment in the rotation in the R2 direction of the rotor **107** with respect to the accommodating case **103**.

The accommodating case **103** includes a cylinder potion **115** having the cylindrical inner peripheral surface **102**; a collar portion **119** which is integrally formed radially inwardly on one annular end portion **116** in an A direction, i.e., an axial direction, of the cylinder portion **115**, and which has an inner peripheral surface **118** defining a through hole **117**; and a cover **122** secured to the other annular end portion **120** in the A direction of the cylinder portion **115** by means of a plurality of screws **121**.

The collar portion **119** at its one side surface **125** in the A direction defines one side of the space **106** in the A direction. The cover **122** includes an oval plate-like portion **130** which has a through hole **126** formed in its center and a pair of through holes **127** and **128** respectively formed in its both end portions, and which at its side surface **129** in the A direction defines the other side of the space **106** in the A direction, as well as a cylindrical projection **131** which is integrally formed on the one side surface **129** of the plate-like portion **130**.

The hollow rotor **107** at its annular end portions **132** and **133** in the axial direction A is supported by the inner peripheral surface **118** of the collar portion **119** of the accommodating case **103** and by an inner peripheral surface **134** of the plate-like portion defining the through hole **126**, so as to be rotatable in the R1 and R2 directions. An inner peripheral surface **136** of the rotor **107**, which defines a hollow portion **135**, has serrations **137**.

Seal rings **138** for preventing the leakage of the viscous fluid **105** from the space **106** to outside the accommodating case **103** are respectively disposed between the inner peripheral surface **118** of the collar portion **119** and the end portion **132** in the axial direction A of the rotor **107**, between the end portion **120** of the cylinder portion **115** and the projection **131** fitted to the end portion **120**, and between the inner peripheral surface **134** of the plate-like portion **130** and the end portion **133** in the axial direction A of the rotor **107**.

The vane means **108** has a pair of elastic vanes **143** and **144** for partitioning into two chambers **141** and **142** the annular space **106** inside the accommodating case **103** accommodating the viscous fluid **105** between the cylindrical inner peripheral surface **102** of the accommodating case **103** and the cylindrical outer peripheral surface **104** of the rotor **107** concentric with the inner peripheral surface **102**, as well as a pair of elastic vanes **149** and **150** serving as other vanes for further partitioning into two chambers at least one of the two chambers **141** and **142** partitioned by the pair of elastic vanes **143** and **144**, i.e., in this embodiment partitioning the respective ones of the two chambers **141** and **142** into two chambers **145** and **146** and two chambers **147** and **148**.

As for the elastic vanes **143** and **144** and the elastic vanes **149** and **150**, since both the elastic vanes **143** and **144** and both the elastic vanes **149** and **150** are formed in a mutually similar manner with symmetrical shapes about the axis O, a detailed description will be given hereafter of the elastic vane **143** and the elastic vane **149**. As for the elastic vane **144** and the elastic vane **150**, a description and an illustration will be given by using the same reference numerals as those of the elastic vane **143** and the elastic vane **149**.

The elastic vane **143** partitioning into the chamber **146** and the chamber **147** includes a curved projecting surface **161** which is continuously connected at its one end portion to the outer peripheral surface **104** of the rotor **107** and which is projecting in the R2 direction of the rotor **107** with respect to the accommodating case **103**, as well as a curved recessed surface **162** which is continuously connected at its one end portion to the outer peripheral surface **104** of the rotor **107** in correspondence with the projecting surface **161**, and which extends along the projecting surface **161** so as to gradually approach the projecting surface **161** from the one end portion to the other end portion of the projecting surface **161**, and terminates at a terminating end of the projecting surface **161**.

The projecting surface **161** has on its other end portion side a circular arc-shaped projecting surface **165** which forms between the same and the inner peripheral surface **102** of the cylinder portion **115** a pair of wedge spaces **163** and **164** opposing each other in the R1 and R2 directions, i.e., a rotational direction R of the relative rotation of the rotor **107** with respect to the accommodating case **103**, and which has a smaller radius of curvature than the radius of curvature of the inner peripheral surface **102**. The circular arc-shaped projecting surface **165** determines the width in the B direction, i.e., the radial direction, of the one wedge space **163** communicating with the chamber **146** such that the width in the radial direction of the one wedge space **163** becomes gradually narrow toward the other wedge space **164** in the rotational direction R. Also, the circular arc-shaped projecting surface **165** determines the width in the B direction of the other wedge space **164** communicating with the chamber **147** such that the width in the B direction of the other wedge space **164** becomes gradually narrow toward the one wedge space **163** in the rotational direction R. Thus, the viscous fluid **105** passing through the pair of wedge spaces **163** and **164** is adapted to determine the width in the B direction of the pair of wedge spaces **163** and **164** by means of its viscosity by elastically deflecting the elastic vane **143**.

By virtue of the above-described projecting surface **161** and the recessed surface **162**, the elastic vane **143** is formed such that its thickness in the R1 and R2 directions, i.e., in the circumferential direction R, decreases gradually from the outer peripheral surface **104** toward the inner peripheral surface **102**, and becomes gradually thinner from its proximal portion **167** which is formed in a circular arc shape and is continuously connected to the rotor **107** to its free end portion **166** having the circular arc-shaped projecting surface **165**.

In the rotation in the R1 direction of the rotor **107** with respect to the accommodating case **103**, the viscous fluid **105** which passes through the pair of wedge spaces **163** and **164** flows from the other chamber **147** into the one chamber **146** by passing through the pair of narrowed wedge spaces **164** and **163**, and is thus adapted to generate large flow resistance which is defined by the pair of narrowed wedge spaces **164** and **163** and resists that rotation in the R1 direction. Meanwhile, in the rotation in the R2 direction of the rotor **107** with respect to the accommodating case **103**, the viscous fluid **105** flows from the one chamber **146** into the other chamber **147** by passing through the pair of widened wedge spaces **163** and **164**, and is thus adapted to generate small flow resistance which is defined by the pair of widened wedge spaces **163** and **164** and resists that rotation in the R2 direction.

Also, the elastic vane **144** partitioning into the chamber **145** and the chamber **148** is formed in the same way as the elastic vane **143**. The viscous fluid **105** passing through the pair of wedge spaces **163** and **164** in the elastic vane **144** is also adapted to determine the width in the B direction of the pair of wedge spaces **163** and **164** by means of its viscosity by elastically deflecting the elastic vane **144**. In the rotation in the R1 direction of the rotor **107** with respect to the accommodating case **103**, the viscous fluid **105** which passes through the pair of wedge spaces **163** and **164** in the elastic vane **144** flows from the other chamber **145** into the one chamber **148** by passing through the pair of narrowed wedge spaces **164** and **163**, and is thus adapted to generate large flow resistance which is defined by the pair of narrowed wedge spaces **164** and **163** and resists that rotation in the R1 direction. Meanwhile, in the rotation in the R2 direction of the rotor **107** with respect to the accommodating case **103**, the viscous fluid **105** flows from the one chamber **148** into the other chamber **145** by passing through the pair of widened wedge spaces **163** and **164**, and is thus adapted to generate small flow resistance which is defined by the pair of widened wedge spaces **163** and **164** and resists that rotation in the R2 direction.

The elastic vane **149** partitioning the chamber **141** into the two chambers **145** and **146** contiguous in the rotational direction R in cooperation with the elastic vanes **143** and **144** includes a proximal portion **173** which has a circular arc-shaped recessed surface **171** complementary to the projecting surface **161** of the elastic vane **143** in such a manner as to oppose the projecting surface **161** of the elastic vane **143** in the rotational direction R and has a cross-sectionally V- or U-shaped recessed surface **172** in such a manner as to oppose the recessed surface **162** of the elastic vane **144** in the rotational direction R, as well as an elastically flexible tongue portion **175** which is integrally formed on the proximal portion **173** and opposes at its circular arc-shaped surface **174** the outer peripheral surface **104** of the rotor **107**. A pair of wedge spaces similar to the pair of wedge spaces **163** and **164** are adapted to be formed between the outer peripheral surface **104** of the rotor **107** and the circular arc-shaped surface **174** of the tongue portion **175** having a larger radius of curvature than that of the outer peripheral surface **104**. In the same way as the elastic vane **143**, the elastic vane **149** forming the pair of wedge spaces similar to the pair of wedge spaces **163** and **164** at the circular arc-shaped surface **174** of the tongue portion **175** is adapted to allow the flow of the viscous fluid **105** from the chamber **145** into the chamber **146** through the pair of wedge spaces with large resistance in the relative rotation in the R1 direction of the rotor **107** with respect to the accommodating case **103**, and is adapted to allow the flow of the viscous fluid **105** from the chamber **146** into the chamber **145** with small resistance in the relative rotation in the R2 direction of the rotor **107** with respect to the accommodating case **103**.

Also, the elastic vane **150** partitioning the chamber **142** into the two chambers **147** and **148** contiguous in the rotational direction R in cooperation with the elastic vanes **143** and **144** is formed in the same way as the elastic vane **149**. In the same way as the elastic vane **149**, the elastic vane **150** forming the pair of wedge spaces between the outer peripheral surface **104** of the rotor **107** and the circular arc-shaped surface **174** of the tongue portion **175** is adapted to allow the flow of the viscous fluid **105** from the chamber **147** into the chamber **148** through the pair of wedge spaces with large resistance in the relative rotation in the R1 direction of the rotor **107** with respect to the accommodating case **103**, and is adapted to allow the flow of the viscous fluid **105** from the chamber **148** into the chamber **147** with small resistance in the relative rotation in the R2 direction of the rotor **107** with respect to the accommodating case **103**.

The one end surface in the A direction of each of the elastic vanes **143** and **144** is in close contact with the side surface **125** of the collar portion **119** slidingly movably in the R1 and R2 directions. Also, the other end surface in the A direction of each of the elastic vanes **143** and **144** is in close contact with the side surface **129** of the plate-like portion **130** slidingly movably in the R1 and R2 directions. The portion of each of the elastic vanes **149** and **150** whose proximal portion **173** is integrally formed on the inner peripheral surface **102** of the cylinder potion **115** is at its one end surface in the A direction in close contact with the side surface **125** of the collar portion **119** slidingly movably. Meanwhile, the portion of each of the elastic vanes **149** and **150** whose proximal portion **173** is integrally formed on the inner peripheral surface of the projection **131** is at its one end surface **181** in the A direction liquid-tightly in close contact with the other end surface **182** in the A direction of the portion of the respective one of the elastic vanes **149** and **150** whose proximal portion **173** is integrally formed on the inner peripheral surface **102** of the cylinder portion **115**, and is at its other end surface in the A direction in close contact with the side surface **129** of the plate-like portion **130** slidingly movably.

As shown in FIGS. **14** to **16**, the above-described rotary damper **101** is used, for example, as a braking mechanism for the rotation of a backrest portion **187** in the R1 and R2 directions with respect to a seat portion **186** in a vehicle seat **188** equipped with the seat portion **186** mounted fixedly on a vehicle body **185** and the backrest portion **187** mounted by being coupled to the seat portion **186** rotatably in the R1 and R2 directions about the axis O. The rotary damper **101** in this case is used by securing the plate-like portion **130** of the cover **122** and, hence, the accommodating case **103** to one of the seat portion **186** and the backrest portion **187**, i.e., in this embodiment the seat portion **186**, by means of screws **191** inserted in the through holes **127** and **128**, and by coupling the rotor **107** to the other one of the seat portion **186** and the backrest portion **187**, i.e., in this embodiment the backrest portion **187**, by means of a rotating shaft **193** whose one end portion **192** is inserted in the hollow portion **135** of the rotor **107**. The rotating shaft **193** with its other end secured to the backrest portion **187** is coupled to the rotor **107** as serrations **194** provided on the one end portion **192** are fitted to the serrations **137** of the rotor **107**. Hence, in the rotation in the R1 and R2 directions of the rotating shaft **193** and, hence, in the rotation in the R1 and R2 directions of the backrest portion **187**, the rotor **107**, which is coupled to the backrest portion **187** by means of the rotating shaft **193**, more particularly by means of the serrations **137** and the serrations **194** of the rotating shaft **193** fitted to the serrations **137**, is adapted to be rotated in the same direction. Thus, the rotor **107** is coupled and fixed to the backrest portion **187**.

In the vehicle seat **188** equipped with the seat portion **186** mounted on the vehicle body **185** of the automobile and the backrest portion **187** coupled rotatably to the seat portion **186**, the backrest portion **187** is coupled to the seat portion **186** rotatably in the R1 and R2 directions about the axis O from an initial rotational position P**0** at which the backrest portion **187** is inclined backward by a predetermined angle α, e.g., $\alpha=25°$, with respect to a vertical plane **195** perpendicular to the front-back direction to a folded rotational position P**1** at which the backrest portion **187** is inclined forward by a predetermined angle β, e.g., $\beta=90°$, with respect to the vertical plane **195**. At the initial rotational position P**0**, the backrest portion **187** is inhibited from rotating in the R1 and R2 directions by an unillustrated unlockable lock mechanism. As the lock mechanism is unlocked, from the initial rotational position P**0** to the folded rotational position P**1**, the backrest portion **187** is adapted to be rotated in the R1 direction in opposition to the relatively large flow resistance of the viscous fluid **105** which passes through the pairs of wedge spaces including the pairs of wedge spaces **163** and **164** due to the elastic vanes **143** and **144** as well as **149** and **150**. Meanwhile, from the folded rotational position P**1** to the initial rotational position P**0**, the backrest portion **187** is adapted to be rotated in the R2 direction by manual rotation in opposition to the relatively small flow resistance of the viscous fluid **105** which passes through the pairs of wedge spaces including the wedge spaces **163** and **164**.

With the above-described rotary damper **101** which functions as such a unidirectional rotary damper, when, upon unlocking of the lock mechanism at the rotational position (corresponding to the initial rotational position P**0**) of the rotor **107** shown in FIG. **17**, the backrest portion **187** is rotated in the R1 direction, and the rotor **107** is rotated in the R1 direction with respect to the accommodating case **103** so as to reduce the chambers **145** and **147** and enlarge the chambers **146** and **148**, the pressure of the viscous fluid **105** is imparted to the recessed surfaces **162** of the elastic vanes **143** and **144** and the recessed surfaces **172** of the elastic vanes **149** and **150**. Therefore, the free end portion **166** side, i.e., the other end portion side, of each of the elastic vanes **143** and **144** approaches the inner peripheral surface **102** of the accommodating case **103**, and the tongue portion **175** side of each of the elastic vanes **149** and **150** approaches the outer peripheral surface **104** of the rotor **107**, so that the elastic vanes **143** and **144** and the elastic vanes **149** and **150** are elastically deformed so as to reduce the pairs of wedge spaces including the pairs of wedge spaces **163** and **164**. As a result, the viscous fluid **105** flows from each of the chambers **145** and **147** into each of the chambers **148** and **146** and into each of the chambers **146** and **148** by passing through the pairs of wedge spaces including the pairs of narrowed wedge spaces **163** and **164**. Thus, large braking due to the relatively large flow resistance of the viscous fluid **105** passing through the pairs of wedge spaces including these narrowed wedge spaces **163** and **164** is imparted to the rotation in the R1 direction of the rotor **107**, to thereby rotate the backrest portion **187** slowly in the same direction up to the folded rotational position P**1**. Meanwhile, when, at the rotational position (corresponding to the folded rotational position P**1**) of the rotor **107** shown in FIG. **18**, the backrest portion **187** is manually rotated in the R2 direction, and the rotor **107** is rotated in the R2 direction with respect to the accommodating case **103** so as to enlarge the chambers **145** and **147** and reduce the chambers **146** and **148**, the pressure of the viscous fluid **105** is imparted to the respective curved projecting surfaces **161** of the elastic vanes **143** and **144** and the recessed surfaces **171** of the elastic vanes **149** and **150**. Therefore, the free end portion **166** side of each of the elastic vanes **143** and **144** moves away from the inner peripheral surface **102** of the accommodating case **103**, and the tongue portion **175** of each of the elastic vanes **149** and **150** moves away from the outer peripheral surface **104** of the rotor **107**, so that the elastic vanes **143** and **144** and the elastic vanes **149** and **150** are elastically deformed so as to widen the pairs of wedge spaces including the pairs of wedge spaces **163** and **164**. As a result, the viscous fluid **105** flows from each of the chambers **146** and **148** into each of the chambers **147** and **145** and into each of the chambers **145** and **147** by passing through the pairs of wedge spaces including the pairs of widened wedge spaces **163** and **164**. Thus, small braking due to the relatively small flow resistance of the viscous fluid **105** passing through the pairs of wedge spaces including these widened wedge spaces **163** and **164** is imparted to the rotation in the R2 direction of the rotor **107**, so that the backrest portion **187** is adapted to be rotated up to the initial rotational position P0 by a small manual force.

According to such a rotary damper **101**, when the backrest portion **187** is rotated from the initial rotational position P**0** to the folded rotational position P**1**, large flow resistance can be generated in the viscous fluid **105** by the vane means **108**. As a result, appropriate resistance can be imparted to the rotation of the backrest portion **187** in the direction toward the folded rotational position P**1** to make it possible to avoid the collision of the backrest portion **187** at the folded rotational position P**1**, and the backrest portion **187** can be easily rotated manually from the folded rotational position P**1** to the initial rotational position P**0**.

In addition, with the rotary damper **101** functioning as a unidirectional damper, the viscous fluid **105** whose viscosity declines with a temperature rise is adapted to pass through the pairs of wedge spaces including the pairs of wedge spaces **163** and **164** in the rotation in the R1 and R2 directions of the rotor **107**. Therefore, in a case where, for example, the viscous fluid **105** whose viscosity at low temperature has increased more than at normal temperature passes through the wedge spaces **163** and **164**, the elastic vane **143** is caused to undergo large elastic deformation such that the free end portion **166** side of the elastic vane **143** moves away from the inner peripheral surface **102** of the accommodating case **103** more than at normal temperature owing to the increased pressure of the viscous fluid **105** at the wedge spaces **163** and **164**, so that the wedge spaces **163** and **164** are largely widened as compared with the time of normal temperature. As a result, by virtue of an increase in the flow resistance based on the increased viscosity of the viscous fluid **105** itself and a decline in the flow resistance based on the widening of the wedge spaces **163** and **164**, it is possible to maintain the braking persisting during normal temperature despite the low temperature. Meanwhile, in a case where the viscous fluid **105** whose viscosity at high temperature has decreased more than at normal temperature passes through the wedge spaces **163** and **164**, the elastic vane **143** is caused to undergo small elastic deformation such that the free end portion **166** side of the elastic vane **143** approaches the inner peripheral surface **102** of the accommodating case **103** more than at normal temperature owing to the decreased pressure of the viscous fluid at the wedge spaces **163** and **164**, so that the wedge spaces **163** and **164** are narrowed. As a result, by virtue of a decrease in the flow resistance based on the decreased viscosity of the viscous fluid **105** itself and an increase in the flow resistance based on the narrowing of the wedge spaces **163** and **164**, it is possible to maintain the braking persisting during normal temperature despite the high temperature. Hence, the braking which is generated is free of temperature dependence, and it is possible to obtain braking which does not change even at high temperature or low temperature. In consequence, the backrest portion **187** can be reliably rotated to the folded positional position P**1**, and can be rotated to be returned to the initial rotational position P**0** with a fixed small manual force.

Although the vane means **108** of the above-described rotary damper **101** has two pairs of elastic vanes **143** and **144** as well as **149** and **150**, the rotary damper in accordance with the invention may have one pair of elastic vanes **143** and **144** and the elastic vane **149** or **150**, or may have three or more pairs of elastic vanes. Further, although the rotary damper **101** is arranged to form a pair of wedge spaces between the circular arc-shaped surface **174** of the tongue portion **175** of each of the elastic vanes **149** and **150** and the outer peripheral surface **104** of the rotor **107**, the rotary damper **101** may be arranged such that the pair of wedge spaces are not formed by causing the circular arc-shaped surface **174** of the tongue portion **175** of each of the elastic vanes **149** and **150** and the outer peripheral surface **104** of the rotor **107** to be brought into tight frictional contact with each other slidably in the R1 and R2 directions.

DESCRIPTION OF REFERENCE NUMERALS AND SIGNS

1: rotary damper
2: interior

3: viscous fluid
4: accommodating case
5, **6**: chamber
9: rotor

The invention claimed is:

1. A rotary damper comprising: an accommodating case having a cylindrical inner peripheral surface; a rotor disposed in an interior of said accommodating case relatively rotatably with respect to said accommodating case so as to form a space for accommodating between the cylindrical inner peripheral surface of said accommodating case and a cylindrical outer peripheral surface concentric with that inner peripheral surface a viscous fluid whose viscosity declines with a temperature rise; and vane structure disposed in the space accommodating the viscous fluid between the cylindrical inner peripheral surface of said accommodating case and the cylindrical outer peripheral surface of said rotor so as to cause large flow resistance to be generated in the viscous fluid in the relative rotation in a first rotational direction of said rotor with respect to said accommodating case and so as to cause smaller flow resistance than that flow resistance to be generated therein in the relative rotation in a second rotational direction opposite to the relative rotation in the first rotational direction,

wherein said vane structure has a pair of elastic vanes for partitioning into two chambers the space accommodating the viscous fluid between the cylindrical inner peripheral surface of said accommodating case and the cylindrical outer peripheral surface of said rotor and another elastic vane for further partitioning into two chambers at least one of the two chambers partitioned by the pair of elastic vanes,

wherein each of the pair of elastic vanes includes a curved projecting surface which is continuously connected at one end portion of the curved projecting surface to the outer peripheral surface of said rotor and which is projecting in the second opposite rotational direction, and a curved recessed surface which is continuously connected at one end portion of the curved recessed surface to the outer peripheral surface of said rotor in correspondence with the projecting surface, and which extends along the projecting surface,

wherein the projecting surface has on another end portion side of the projecting surface a circular arc-shaped projecting surface which forms between the circular arc-shaped projecting surface and the inner peripheral surface of said accommodating case a pair of wedge spaces opposing each other in the first and second rotational directions, the circular arc-shaped projecting surface determines a radial width of one of the wedge spaces communicating with one of the two chambers adjacent to each other with the circular arc-shaped projecting surface therebetween in the first and second rotational directions, such that the radial width of the one wedge space becomes gradually narrow toward another one of the wedge spaces communicating with another one of the chambers adjacent to each other with the circular arc-shaped projecting surface therebetween in the first and second rotational directions, and the circular arc-shaped projecting surface determines a radial width of the other wedge space communicating with the other one of the two chambers adjacent to each other with the circular arc-shaped projecting surface therebetween in the first and second rotational directions, such that the radial width of the other wedge space becomes gradually narrow toward the one wedge space communicating with the one of the two chambers adjacent to each other with the circular arc-shaped projecting surface therebetween in the first and second rotational directions, the viscous fluid passing through the pair of wedge spaces is adapted to determine the radial width of the pair of wedge spaces by means of a viscosity of the viscous fluid by elastically deflecting each of the pair of elastic vanes,

wherein the other elastic vane includes a proximal portion which is united with the inner peripheral surface of said accommodating case and which has a circular arc-shaped recessed surface complementary to the projecting surface of at least one of the pair of elastic vanes in such a manner as to oppose the projecting surface of at least one of the pair of elastic vanes in the second rotational direction and an elastically flexible tongue portion which is integrally formed on the proximal portion and has a circular arc-shaped surface opposing the outer peripheral surface of said rotor, and

wherein the projecting surface of at least one of the pair of elastic vanes is adapted to be capable of coming into contact with said circular arc-shaped recessed surface in the second rotational direction.

2. The rotary damper according to claim **1**, wherein the circular arc-shaped projecting surface has a smaller radius of curvature than a radius of curvature of the inner peripheral surface of said accommodating case.

3. The rotary damper according to claim **1**, wherein the recessed surface extends along the projecting surface so as to gradually approach the projecting surface from the one end portion to the other end portion of the projecting surface.

4. A rotary damper comprising: an accommodating case having a cylindrical inner peripheral surface; a rotor disposed in an interior of said accommodating case relatively rotatably with respect to said accommodating case so as to form a space for accommodating a viscous fluid; and vane structure disposed in the space accommodating the viscous fluid between the cylindrical inner peripheral surface of said accommodating case and a cylindrical outer peripheral surface of said rotor so as to cause large flow resistance to be generated in the viscous fluid in the relative rotation in a first rotational direction of said rotor with respect to said accommodating case and so as to cause smaller flow resistance than that flow resistance to be generated therein in the relative rotation in a second rotational direction opposite to the relative rotation in the first rotational direction,

wherein said vane structure has a pair of elastic vanes for partitioning into two chambers the space accommodating the viscous fluid between the cylindrical inner peripheral surface of said accommodating case and the cylindrical outer peripheral surface of said rotor and another elastic vane for further partitioning into two chambers at least one of the two chambers partitioned by the pair of elastic vanes,

wherein each of the pair of elastic vanes includes a curved projecting surface which is continuously connected at one end portion of the curved projecting surface to the outer peripheral surface of said rotor and which is projecting in the second rotational direction,

wherein the projecting surface has on another end portion side of the projecting surface a circular arc-shaped projecting surface which forms between the circular arc-shaped projecting surface and the inner peripheral surface of said accommodating case a pair of wedge spaces opposing each other in the first and second rotational directions,

wherein the other elastic vane includes a proximal portion which is integrally formed on the inner peripheral surface of said accommodating case and which has a circular arc-shaped recessed surface complementary to the projecting surface of at least one of the pair of elastic vanes in such a manner as to oppose the projecting surface of at least one of the pair of elastic vanes in the second rotational direction and an elastically flexible tongue portion which is integrally formed on the proximal portion and has a circular arc-shaped surface opposing the outer peripheral surface of said rotor, and

wherein the projecting surface of at least one of the pair of elastic vanes is adapted to be capable of coming into contact with said circular arc-shaped recessed surface in the second rotational direction.

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